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CONTRIBUTION  
TO THE  
STUDY OF THE BLOOD IN  
GENERAL PARESIS.

BY

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## CONTRIBUTION TO THE STUDY OF THE BLOOD IN GENERAL PARESIS.

BY SMITH ELY JELLIFFE, A. B., M. D.\*  
From the Binghamton State Hospital Laboratories.

General paresis is such a well marked form of mental disease that any study of its underlying causative factors presents a special attractiveness that is wanting in many other forms of mental impairment. It is probably due to this fact, in part at least, that so much work has been done in this disease. The blood has received its share of attention.

The most excellent paper of Capps would seem to leave nothing more to be said upon the subject and had not the writer's experience, with some twenty cases observed at the Binghamton State Hospital, pointed to somewhat different conclusions the following study would not be presented.

From the amount of work done thus far, it would appear that broad generalizations upon the condition of the blood are not yet possible. In this paper the writer hopes to present some more facts, not necessarily new, whereby a more correct approximation to the average may be drawn. Insanity is after all a question of averages, and it may be that the blood in general paresis varies within broad lines in much the same manner that the psychical activities vary.

The different observers who have worked upon the blood of general paresis have viewed it from different standpoints. Capps has already briefly recapitulated the work of the earlier authors from Erlenmeyer in 1846 to the present time. Thus Erlenmeyer in 1846 and Hittorf

\* It is with pleasure that I here express my obligations to Dr. Chas. G. Wagner for the privilege of spending a summer at the Binghamton State Hospital. My thanks are also expressed to members of the staff of that institution, Drs. Eastman, White, MacCoy, and Eggleston, who made me welcome and did everything in their power to aid me in this and other studies. I am also indebted to Mr. Bert E. Nelson and Mr. M. Boulgourjoo for much assistance in the counting and gathering of specimens.

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in 1847 both came to the general conclusions that the number of globules was reduced and that the blood appeared more watery in this disease. Michea and Sutherland both record an increase in the red blood cells, and the latter author states that there is an increase in the leucocytes.

None of these earlier contributions were made with instruments of precision and cannot be regarded as evidence from the present point of view. MacPhail may be considered to be the first author to use such instruments.

MacPhail studied some fifteen or more cases, taking care to observe the distinctions in the different stages of the disease as seen from the clinical standpoint; thus for the first stage his figures run:\*

CASE.	DURATION.	HÆOMGLOBIN.	HÆMOCYTES.	LEUCOCYTES.
1 ...	6 months	... 68 per ct.	... 4,450,000	... 15,890
2 ...	12 "	... 62 "	... 4,405,000	... 12,710
3 ...	9 "	... 66 "	... 4,420,000	... 17,000
4 ...	3 "	... 70 "	... 4,515,000	... 14,500
5 ...	4 "	... 65 "	... 4,380,000	... 12,880

Thus all of these cases show a marked decrease of hæmocytes and a moderate degree of leucocytosis.

If we follow Cabot in his statement, p. 83, that one may expect to find leucocytes varying from 3,000-10,500 in normal cases, and Rieder and Reinert that digestion leucocytosis may reach 33 per cent above the normal, even then MacPhail's figures show leucocytosis. For the second stage the results show:

CASE.	DURATION.	HÆMOGLOBIN.	HÆMOCYTES.	LEUCOCYTES.
1 ...	3 years	... 75 per ct.	... 4,495,000	... 18,000
2 ...	9 months	... 65 "	... 4,380,000	... 19,000
3 ...	1 year	... 72 "	... 4,265,000	... 23,700
4 ...	1 "	... 70 "	... 4,220,000	... 23,400
5 ...	9 months	... 68 "	... 4,265,000	... 30,400

This shows a marked accentuation of the same kind as noted for the first stage, save that the hæmoglobin is higher.

\* MacPhail gives his numbers of red cells in percentage of 5,000,000 and his white cells are recorded in proportion to the red ones. These have been calculated so as to bring the results in accord with the scheme of enumeration.

For the terminal stage his figures run:

CASE.	DURATION.	HÆMOGLOBIN.	HÆMOCYTES.	LEUCOCYTES.
1	18 months+	58 per ct.	3,880,000	27,700
2	16 "	64 "	4,055,000	28,900
3	8 "	55 "	3,445,000	31,400
4	6 "	66 "	4,525,000	34,300
5	9 "	60 "	4,020,000	36,600

His summary is as follows:

(1)—Hæmoglobin is low on admission, it improves in the second stage and again falls in the third stage.

(2)—The red cells deteriorate in quantity and quality with the progress of the disease.

(3)—Small granule cells are not present in the blood during the last stage.

(4)—Leucocytosis gradually increases as the disease progresses.

Bevan Lewis is quoted by Capps as stating that the red cells are diminished in general paresis. I am unable to verify this statement, as Lewis says: "A diminution of hæmoglobin is clearly indicated in all cases of general paralysis examined by me. The *corpuscular richness* varies considerably, in fact, from 75-126 per hæmic unit, the higher register pertaining to cases where maniacal excitement prevailed. No connection is established, however, between mania and such corpuscular richness, since a diminution in the number of red cells is quite as often, and, in our experience, more frequently, met with in maniacal conditions."

Calculating Lewis' tables, we obtain the following:

CASE.	HÆMOGLOBIN.	RED CELLS.	WHITE CELLS PER HÆMIC UNIT.
1	71 per ct.	6,250,000	.40
2	70 "	5-6,000,000	.15
3	60-65 "	4,250,000-5,500,000	.45
4	58 "	4,560,000	.20
5	53 "	4,000,000	.35
6	66 "	5,111,000	.25
7	68 "	5,030,000	.24
8	60 "	4,360,000	.32
9	70 "	4,550,000	.22

CASE.	HÆMOGLOBIN.	RED CELLS.	WHITE CELLS PER HÆMIC UNIT
10	62—70	4,090,000	50
11	64	3,950,000	20
12	70	3,920,000	22
13	68	4,090,000	20
14	..	3,860,000	25
15	64	.....	10

Smyth has published the longest list of cases, but he made no differential leucocyte counts; but his figures however, we believe, are worth giving.

His conclusions are:

(1)—Hæmoglobin shows no marked changes, the exalted conditions seeming to increase it.

(2)—Red cells lost in melancholia, epilepsy and general paresis, the diminution being least in general paresis.

(3)—The specific gravity is higher than in the normal condition, 1055 being the standard.

His tables (hæmoglobin estimated by Roy's apparatus) are as follows:

CASE.	HÆMOGLOBIN.	HÆMOCYTES.	SP. GR.
1	70 per ct.	4,600,000	1060
2	80	5,010,000	1060
3	60	4,520,000	1059
4	70	4,250,000	1062
5	65	4,680,000	1059
6	65	4,440,000	1062
7	55	4,620,000	1058
8	58	4,280,000	1061
9	64	4,850,000	1061
10	65	5,200,000	1061
11	70	4,890,000	1059
12	75	4,450,000	1049
13	70	4,620,000	1061
14	65	4,920,000	1059
15	70	4,870,000	1059
16	72	4,680,000	1061
17	74	4,820,000	1061
18	70	3,960,000	1061
19	74	4,980,000	1061
20	70	4,680,000	1058
21	60	4,460,000	1060

CASE.	HÆMOGLOBIN.	HÆMOCYTES.	SP. GR.
22	58 "	4,560,000	1059
23	58 "	4,280,000	1057
24	72 "	4,560,000	1062
25	68 "	4,820,000	1067
26	63 "	4,920,000	1057
27	70 "	5,100,000	1056
28	70 "	4,340,000	1060
29	72 "	4,860,000	1058
30	71 "	4,910,000	1058
31	72 "	4,908,000	1060
32	74 "	4,701,000	1062
33	70 "	4,620,000	1060
34	70 "	5,190,000	1059
35	74 "	4,500,000	1062
36	70 "	4,630,000	1060
37	74 "	4,501,000	1062
38	70 "	5,160,000	1059
39	73 "	4,690,000	1059
40	76 "	4,910,000	1063

Winckler states, from a record of twenty-one cases of general insanity, that hæmoglobin and red cells vary with body weight. They both decrease in the early stage, are stationary in the second stage and again decrease in the third stage.

Krypiakiewicz studied the eosinophiles mainly. In a total of fifteen cases he observed no increase in these cells, and leucocytosis was observed in some cases only. Hæmoglobin and red corpuscles were diminished and poikilocytosis was present.

Zappert gives the following figures for two cases observed by him:

CASE.	HÆMOCYTES.	LEUCOCYTES.	EOSINOPHILES.
1	4,200,000	7,300	Decreased.
2	4,100,000	8,000	1.94 per ct.

Houston published the results of four examinations; his figures were as follows:

CASE.	HÆMOGLOBIN.	HÆMOCYTES.
1	70 per cent.	4,820,000
2	78 "	4,940,000
3	80 "	4,880,000
4	73 "	4,340,000

He does not give any figures of the leucocytes but estimates them to be about normal.

Roncoroni was concerned mainly with the eosinophiles. As quoted from Capps, "These he found to vary, at times very scarce, rarely in normal frequency, in extremely agitated cases with a tendency to violence they increase from 8 to 18 per cent, and, in one instance, even to 25 per cent of the total number of leucocytes."

In Burton's four cases the figures are:

CASE.	HÆMOGLOBIN.	HÆMOCYTES.	LEUCOCYTES.
1	75 per ct.	6,990,000	13,000
2	65 "	5,260,000	10,000
3	80 "	4,570,000	9,000
4	72 "	3,960,000	9,000

No differential counts of leucocytes are given and, as Capps points out, the classification seems involved.

Somers gives the following figures for general paresis, as the average of five cases: Red cells, 4,266,000; white cells, 88,000; haemoglobin, 74 per cent; eosinophiles in one absent; polynuclear neutrophiles normal in both; poikilocytosis in five; plaques in two; granules in three. Evidently 88,000 is a misprint.

The most exhaustive and by far the best study that we have is that of Capps. His work shows painstaking labor and his results are to be relied upon perhaps even more than those of the present writer, as more time and care were expended in his research. We feel, however, that they do not tell the whole story, hence the publication of this paper. His tables are given on the next page.

Capps' conclusions are as follows:

"In looking over the final table of averages we see that as a whole the haemoglobin in general paresis ranges from 73 to 92 per cent, never falling below 70 per cent. The percentage is usually higher several months after admission, which is probably due more to hospital care and abundant good food than to any change in the disease.

The specific gravity varies from 1058 to 1066, a difference that may be noted in healthy individuals. The average

CAPP'S TABLES.

Case	White Cells.	Red Cells.	Sp. Gr.	Haemoglobin.	Lymphocytes.	L. Mono-nuclear.	Transitional.	Poly-nuclear.	Eosinophiles.	Per Cent.
1	13,575	5,054,700	1060	86.5	12.7	6.6	1.4	77.3	2.	
2	8-10,583	4,617,000	1058	81.	12.9	5.	.7	77.9	3.	
3	9-13,750	5,154,000	1058.5	87.75	12.4	5.8	1.5	78.8	1.5	
4	12,037	4,499,000	1060.5	82.3	13.9	6.8	1.2	75.7	2.3	
5	10,750	4,760,000	1058.5	87.5	16.6	8.6	1.6	71.9	1.0	
6	13,650	4,724,000	1060	80.5	13.5	8.8	1.5	73.7	2.5	
7	13,750	5,045,000	1059.3	99.	14.1	4.1	.9	78.1	2.8	
8	9,975	4,639,000	1057.5	81.	18.1	5.6	1.1	72.4	1.8	
9	14,720	4,800,000	1065	83.	10.9	10.3	1.5	74.1	3.1	
10	11,660	4,680,000	1058.8	79.8	13.5	4.8	1.7	73.6	6.4	
11	7- 8,467	4,949,000	1061.3	85.6	16.4	12.6	1.	68.6	1.4	
12	14,920	4,989,000	1062	87.5	13.7	8.2	1.1	73.4	3.6	
13	14,330	5,400,000	1065	91.	12.	3.5	.9	83.5	.1	
14	11,821	4,957,000	1060.6	81.	10.9	10.4	3.2	66.8	8.7	
15	11,315	4,684,000	1061	79.5	15.9	7.6	1.8	73.1	1.6	
16	9,130	4,196,000	1062	73.3	14.2	8.1	1.	75.6	1.1	
17	13,165	4,660,000	1061	92.	14.5	10.8	2.1	69.5	3.1	
18	13,586	4,808,000	1062.6	85.6	13.9	6.7	1.1	77.4	.9	
19	12,650	4,390,000	1065	89.	19.4	12.8	2.6	63.6	1.6	

falls somewhat below the normal, but the tendency is not pronounced enough to make it of any practical importance.

Much more constant is the diminished numbers of red corpuscles which in only four cases reaches 5,000,000. Nevertheless they maintain a much better average than some observers have stated.

The leucocytosis is never very great, but considering that it is present in some degree in the great majority of a large number of observations, we are led to believe that in most cases of general paralysis there is slight leucocytosis, amounting on an average to twenty-two per cent increase over the normal. Of three cases examined within four months of the beginning of the disease, two had no leucocytosis, a third, of longer duration and rapid in its progress, exhibited a decided increase in the white corpuscles. From these few results it seems that *early cases of general paralysis may have no leucocytosis whatever unless accompanied by excitement or running a rapid course.* Nothing further can be said with regard to a correspondence between the degree of leucocytosis and the stage of the disease, since, in many instances, the leucocytes are more abundant in the earlier than in the later stages.

In the analysis of the leucocytes, the lymphocytes, in every case but one, are found to fall below the average. The large mononuclear cells, on the other hand, are generally increased, sometimes to three times the usual number. Roughly speaking, the average increase in the large mononuclears affects the diminution in the lymphocytes so that the total mononuclear element is little altered from the normal. The transitional forms nearly always vary with the large mononuclears. The polynuclear cells as a rule vary directly with the leucocytosis as, with but few exceptions, they are the dominant variety.

The eosinophiles are more changeable than any other form, varying from 14 to 1075 in a c.mm. They are inclined to be more plentiful in the cases that are restless and show motor excitement, although sometimes the reverse is true."

This summarizes the work that has thus far come to the notice of the writer. It can be seen that in the main the results are contradictory, at least enough so to make one look further, for a wider point of view.

Turning now from the researches of others to our own investigations we may consider—

1. Technical methods employed;
2. Investigation of cases;
3. General summary of work.

#### I.—METHODS.

The blood was obtained from the ear in the greater number of the cases for the estimation of the corpuscles, as well as for the haemoglobin, and the specific gravity. The counts were made with the regulation Thoma Zeiss apparatus. For the red cells Gowers' dilution fluid was used and the dilution was generally 1—200; a large number of squares was counted, averaging 360. For the white cells the larger bore pipette was used with the  $\frac{1}{3}$  of one per cent aqueous solution of glacial acetic acid. Toison's solution was also used, as the acetic mixture was not always satisfactory, as has been pointed out by Ewing and others.

The haemoglobin was determined in part by the Fleischl haemometer, in part by Hammerschlag's specific gravity method, though more frequently the two were used and an average made of the results.

The specific gravity was determined entirely by Hammerschlag's method.

Cover glass preparations were made by the ordinary methods, as were also smears, made by means of the glass spreader, the films being much more satisfactory with the spreader, especially from some of the patients who were restless and resistant. Blood from the finger was generally used for the permanent preparations. Fixation was accomplished by means of heat, 110 to 115° C., ten to twenty minutes, and by the mixture of equal parts of absolute alcohol and ether. Heat fixation seemed preferable.

Corrosive sublimate fixation was practiced in a few instances. The preparations were stained by the Ehrlich tri-acid stain and also by the eosin methylene blue methods. Finally specimens were mounted in balsam or in "Naphthaline ambar."

In the differential estimate, from 750 to 1500 leucocytes were counted. The nomenclature adopted for the leucocytes is that given in Cabot's most excellent work.

(a) Basophil cells.

(1) Small lymphocytes. Cells averaging 5 to 10 mikra in diameter with basophilic nucleus generally prominent; the cytoplasm of the cell generally being less observable.

(2) Large mononuclear leucocytes, 10 to 15 mikra in diameter, sometimes even larger, with sub-prominent basophil nucleus and abundant cytoplasm which stains but faintly as a general rule.

(b) Acidophil or oxyphil cells.

(3) Transitional forms. Large cells resembling the large momonuclears but having a nucleus with a marked horse-shoe form which takes up the basic coloring matters more markedly than the nuclei of the large leucocytes.

(4) Polymorphonuclear neutrophiles with single much contorted basophil nucleus or numerous basophil nuclei with neutrophilic granules. These granules are regarded by some observers as the microsomes of the mitoma. These are oxyphil in their staining reactions and generally take up the acid aniline dyes of the fluorescin group, such as eosin, erythrosin, etc.

(5) Eosinophile cells: with irregular nucleus or nuclei and large acidophil granules; these granules being the microsomata of the enlarged mitomata, grown larger. (Gulland).

The time of examination for counting as well as for the determination of haemoglobin and specific gravity, as has

frequently been pointed out, is of importance. The time chosen was just before a meal, so that leucocytosis would be at a minimum. Digestion leucocytosis would therefore be ruled out. This is just the reverse of the observations of Capps, and our "apologia" of small counts may offset his of increased ones (p. 654, lines 32-33.)

No regular time was observed in the collection of specimens for the differential count of the leucocytes, as digestion leucocytosis, according to Rieder, does not influence the proportions of the different leucocytes to any great extent.

## II.—STUDY OF CASES.

CASE I.—J. D., laborer; aged fifty-five years; married. Admitted June, 1896, after two weeks' onset. No heredity. Is said to have been insane years ago in Auburn Prison. Just previous to admission he developed persecutory delusions, and also a fine tremor of the muscles of the face, especially about the mouth. At the present time speech is impaired. At times he works himself up into a marked state of excitement. He will lie upon the floor for hours; will throw his arms and legs about, cry, froth at the mouth and exhaust himself generally. He will then lie quietly for a space of time sufficient to get up enough energy for a second fit of anger. His pupils are contracted; his reflexes are diminished. Nutrition fair. Mental state seems to be improving.

This case is not a typical case of general paresis, and subsequent observations may show it to be another form of mental disease. Up to the present time, however, it seems to belong in this category of cases.

The study of the blood shows an increase in the red cells, the largest number under observation 6,800,000. There was no leucocytosis; the haemoglobin and specific gravity were not far from normal. The differential count of leucocytes shows a decrease in the young cells of the blood and an increase in the polymorpho-nuclear neutrophiles; eosinophiles about normal.

CASE II.—A. C. S., a painter by occupation; thirty-seven years of age; widower; admitted September, 1897. The duration of the disease has been about fourteen months. His early psychical history shows the development of delusions of wealth in money and in property.

The patient is quiet and orderly, is beginning to be demented somewhat and is amnesic at times. Speech is somewhat slowed and slurred; cannot repeat expressions such as "truly rural," "third cavalry brigade," etc. Is exalted with persistent delusions of wealth. Pupils are unequal, responding to light and accommodation, the reflexes are diminished; has had no convulsions. He persists in writing numerous letters to members of his family, which letters are not legible.

His blood is normal as far as numbers are concerned, and the specific gravity and haemoglobin are also normal. The differential count of the leucocytes shows a marked diminution in the number of young cells in the blood; a slight increase of the large mononuclear leucocytes and a marked diminution of the polymorphous cells.

CASE III.—J. K., a veterinary dentist by occupation; fifty-five years of age; married; no children. Admitted August, 1896. The family history is negative. The patient has been a heavy drinker. About two months previous to his admission he commenced suddenly to become irritable, especially when crossed. Later, he developed well marked delusions of grandeur. The speech is slowed, though not yet typical of general paresis. There is some mental confusion, and his delusions have become of a hypochondriacal nature. The pupils are equal and react normally; the reflexes are diminished. There have been no convulsions; nutrition good. This case has not yet developed into an absolutely typical case.

The blood is almost normal throughout, save in the diminution of small lymphocytes, where 2.7 per cent instead of from 20 to 30 were recorded.

The case resembles in some respects Case No. II.

CASE IV.—H. H., an engineer; thirty-six years of age; single. Admitted May, 1897. The general hereditary history is negative. Excesses in tobacco and alcohol. After an injury to the head in a railroad wreck, the patient slowly developed a partial paralysis of the right side and aphasia. At the present time he is aphasic, but yells and cries and is markedly depressed at times; no delusions have been elicited. Pupils and reflexes normal; no convulsions. Dementia slight, if any. The time of observation does not permit more than a "suspect" diagnosis of this case.

The blood is practically normal in all respects. The large mononuclear leucocytes run along the higher limits, but the blood is, on the whole, at the normal average.

CASE V.—W. B., salesman; widower; admitted March, 1897. No hereditary history. Alcoholic and tobacco habits. The patient commenced ten months before admission to show signs of mental impairment with gradual onset of feelings of exaltation and of delusions and hallucinations. At the time of admission his speech was slowed and thick. He had many delusions with reference to his own ability and importance and hallucination of sight. Pupils small, equal, reacting normally, reflexes markedly increased; no convulsions. His nutrition is excellent. Dementia has steadily progressed so that at the present time he realizes nothing of his surroundings. Speech is incoherent and all muscular action very incoördinate.

His blood shows an increase in the red blood cells, the leucocytes are diminished or normal. Haemoglobin and specific gravity slightly below the normal. The differential count of leucocytes shows reduced number of lymphocytes and great increase in the polymorph-neutrophiles.

CASE VI.—D. T. S., veterinary surgeon; single; aged fifty-four. Admitted September, 1896.

One brother was insane. The patient has been a hard drinker, having had four attacks of delirium tremens. The onset of the present disease was somewhat sudden, the early symptoms being delusions of a markedly grandiose character. He has untold millions in every bank in the world, and mountains and mountains of gold; gives checks for fabulous amounts and is God, the Devil, etc. Pupils normal, reflexes are exaggerated; speech somewhat irregular; dementia of second grade. Has recently had five convulsions, lasting five hours. Nutrition good.

The blood shows an increase in the number of red cells and an undoubted leucocytosis; the haemoglobin and specific gravity are both about normal. The leucocytosis is general, no one particular type of cells seemingly increased beyond the others.

CASE VII.—W. S., telegrapher; married; aged forty-one; admitted September, 1895.

The onset was sudden; occurring ten months before admission into the hospital. Convulsions followed by melancholia with persecutory delusions. His memory then began to fail; this resulted in a loss of his position whereupon the melancholia and delusions of persecution were more marked. Hallucinations of sight developed. Took a pillow as his baby, etc. The delusions persist; the pupils are dilated and the reflexes lost. The patient has locomotor ataxia and presents typical combined symptoms. The case resembles No. VIII very much in

the coexistence of general paresis and locomotor ataxia. The mental conditions of exaltation and feelings of *bien être* alternating with melancholia, is also marked in the two cases.

The blood shows a marked diminution in the number of red cells, the leucocytes are about normal and both the haemoglobin and the specific gravity are reduced. The distribution of the leucocytes is practically normal; there is a slight diminution in the number of small lymphocytes and the eosinophiles are few.

CASE VIII.—J. J. W., aged 50; single. Admitted December, 1894. Maternal uncle paretic and one brother insane. The patient has been somewhat intemperate. He has suffered from locomotor ataxia for the past ten years with ataxia, and optic nerve atrophy with consequent blindness. Six weeks before admission he became suddenly exalted and emotional; he had grand ideas of his power and importance and was admitted to the Binghamton State Hospital as a case of acute mania. After six months his delusions subsided and his mental tone was markedly improved. He was discharged in June, 1895, as improved. He was readmitted July, 1896, having recently had two convulsions with varying periods of excitement and depression. Ataxia more marked than at the time of previous admission. The other symptoms were characteristic of general paresis. Unequal temperature; 98 on right, 96.4 on left side, varying from side to side. Lost reflexes, pupils unequal; blind; feels temperature changes easily and is readily suggestible. Highly emotional, with strong sexual excitement; cries easily and then laughs. Nutrition is excellent. His delusions are still of the grandiose type, alternating with a certain amount of melancholia. Has had five convulsions since admission. Dementia slight, stationary for a time.

The blood was obtained with difficulty as he was so suspicious. The count showed an increase of red cells; the leucocytes were within the normal range. Haemoglobin and specific gravity low. The differential count of the leucocytes showed a large number of small lymphocytes, fully up to the higher percentage limit.

In its clinical history this case resembles that of Case VII. The blood was quite different, however.

CASE IX.—J. M., carpenter; married; aged 49. Admitted November, 1895. Mother insane. The disease has had a gradual progress, commencing with a partial loss of memory and fine muscular tremors of face, mouth and tongue. Suffers from depression on

account of his forgetfulness. Since admission has slowly lost ground. Speech is slow, thick and imperfect. Pupils are unequal; reflexes are exaggerated. There have been no convulsions and no well formed delusions. The dementia is steadily progressing. He is orderly and in good physical condition.

The blood is normal throughout, save for the absence of eosinophile cells. These were widely searched for, some several thousand leucocytes having been counted.

CASE X.—J. F., farmer; married; aged fifty-seven. Admitted October, 1895. One sister was insane. The patient commenced to be ill about four months previous to admission into the hospital; he became irritable, and developed delusions of the grandiose type, also somewhat religious; he later became somewhat violent and his language was very voluble and partially incoherent. After admission, continued to be maniacal with persistence of delusions. Pupils unequal; fine tremor of eyelids and muscles of the face; reflexes exaggerated. He occasionally suffers from retention of urine.

In May, 1896, he had severe convulsions, resulting in paralysis of the left arm, leg and side of body; this disappeared in about one month. Since admission, has continued to be exalted, with slowly developing slurred speech and impaired muscular action. Dementia is slow and gradual; about ready to enter the third stage. Has occasional loss of control of bladder and rectum.

The blood is normal, save for a marked increase in haemocytes, the average of several counts being over six million. Specimens were obtained with some difficulty and stained very poorly, especially so with eosin, although the haemoglobin was fairly high, 88 per cent.

CASE XI.—F. K., cigar maker; married; aged thirty-three. Admitted December, 1896. No family history. For a year previous to admission he slowly developed delusions of an extravagant and exalted type. Speech also became involved, being slowed and slurred.

The course of the disease has been gradual and typical, evenly progressing muscular and mental paresis. Pupils dilated; reacting; reflexes exaggerated. At present time is entering upon the third stage of filthy habits, but not yet confined to bed. Nutrition is fair.

The blood shows a marked degree of anaemia, the haemoglobin being about one-half of what it should be; the specific gravity is also low; the haemocytes are increased; the leucocytes diminished. The differential count of the

leucocytes shows that the reduction is evenly distributed among all of the elements.

CASE XII.—A. Z., cigar maker; married; aged thirty-nine. Admitted December, 1895. No family history. Patient has been intemperate, and for the past few years has suffered from a gradually increasing loss of memory, halting and faulty speech and a slowly progressing dementia. After admission the dementia was the only pronounced symptom, later a fine tremor of the muscles of the tongue developed. In April, 1897, he had a series of convulsions with much muscular twitching. Pupils normal; is confined to bed and develops bedsores which heal slowly. Patient is filthy.

The blood is practically normal throughout, save, perhaps, a slight increase in the number of larger mono-nuclear cells and the absence of the eosinophiles.

CASE XIII.—A. J. C., laborer; single; aged thirty-nine. Admitted September, 1896. General family history negative. Has taken alcohol in excess. Syphilis. The early history was one of beginning slight dementia with a few convulsions. This was followed by the expression of exalted ideas. He believed himself to be the governor or some other important State or national official. In August, 1896, he had further convulsions. At present in third stage; is weak; reflexes exaggerated, pupils dilated; speech unintelligible.

The blood shows an increase in the hæmocytes and a slight degree of leucocytosis; the specific gravity and hæmoglobin content are slightly decreased. The differential count shows a large number of eosinophiles—7 per cent; the elements are about the average.

CASE XIV.—W. M., bank cashier; married, aged fifty-four. Admitted July, 1894. No hereditary history. Syphilis. The first symptoms noted were beginning slight aphasia; this lasted for a few months and then ceased, to be followed by another slight attack; then the patient commenced to develop delusions of wealth, "he wrecked a bank," etc. For two years was treated at home, but became very delusional and was sent to the hospital. In September, 1894, March, 1895 and August, 1896, had convulsions.

He has passed through the various stages of the disease very slowly, with increasing dementia and weakness. Is now confined to bed and during the time of observation, August, 1897, he had an evening temperature that varied from 99-104, every day.

The blood shows a slight increase in the red cells. Leucocytes are within the average limits throughout, save

a slight increase in the large mononuclear variety. He may have been suffering from some form of fever at the time of observation, but the diagnosis could not be made definitely. There was no leucocytosis, and no unnatural organisms were found.

CASE XV.—I. R., teamster; married; aged fifty-eight. Admitted Jan. 1897. Family history negative. History of syphilis and alcoholism. The onset was rapid. He became irritable, violent and dangerous, with hallucinations of sight and hearing. Had had a slight convulsion.

After admission the patient suffered from great mental and motor excitement for a couple of months. He then became emaciated and weak and was confined to his bed. Appetite is good, but nutrition is bad. Pupils unequal; reflexes all exaggerated. In July, from 1st to 10th, he had three to four convulsions daily, after which the motor and mental paresis advanced rapidly. Dementia and motor paralysis is now almost complete. The patient, however, is in a contented state of mind and tells one that he is "all right."

This is one of the rapid cases of paresis. The blood is almost normal. There was a slight increase in the number of haemocytes and a reduced percentage of haemoglobin; the differential count of leucocytes showed a diminution in the lymphocytes and a slight increase in the large mononuclear cells. The eosinophiles were entirely lacking.

CASE XVI.—M. C., laborer; married; widower; aged thirty-six. Admitted September, 1896. Family history unknown. Alcoholic excesses. In September, 1895, the first symptoms commenced to appear: mental confusion, and forgetfulness, causing him to lose his situation. Later a fine tremor developed in his lips and he became melancholic. He gives no history of any delusions. His pupils were dilated and his reflexes exaggerated. The dementia has progressed steadily and at the present stage there is also well marked motor impairment, though as yet he is not confined to bed. He is unable to make himself understood if he tries to talk.

The blood shows an increase in the haemocytes and a decrease in the leucocytes. The specific gravity is low and the haemoglobin markedly diminished. The differential count of the leucocytes shows an increase in the large mononuclears, coming chiefly from the small lymphocytes.

CASE XVII.—L. P., female; music teacher; single; aged fifty-five. Admitted March, 1896. One niece is insane. At time of admission was distinctly insane and had been so for three or four years. She was destructive and filthy. Speech was slowed, scanning and incoherent. She had illy defined delusions of persecution and was considerably depressed. Pupils have developed Argyll-Robertson symptoms. The only convulsion occurred quite late in the disease, September, 1897, and was prolonged and severe. She is now a cripple with marked lordosis, and ankylosed knees. Her dementia was profound.

The blood examination was not altogether satisfactory, but the red cells were increased and the leucocytes markedly diminished. The haemoglobin was not determined, nor was the specific gravity. The differential count of leucocytes showed a marked preponderance of the polymorphonuclear leucocytes and a corresponding diminution of the lymphocytes. There were no eosinophile cells found.

CASE XVIII.—G. H. R., laborer; single, aged forty-four. Admitted June, 1895. No family history obtained. The patient gradually developed delusions of persecution; these were followed by mental confusion; dementia and aphasia soon came on.

The patient also has had chronic rheumatism and endarteritis and endocarditis and suffers from valvular lesions. The pupils have been normal throughout; the reflexes have been generally exaggerated. There have been no convulsions throughout the disease. The general paresis has been gradual, rapid and continuous. The patient died in October, 1897.

The blood contained about the average number of red cells; there was slight leucocytosis; the haemoglobin and specific gravity were reduced. The differential leucocyte count showed a normal distribution of these elements.

CASE XIX.—S. G., housewife; aged thirty-eight. Admitted May, 1894. There was no family history obtainable. The onset of the disease was slow, first making itself known by mental depression and the beginning of dementia. She became quite emaciated and melancholic, and subsequently developed a host of delusions. At the time of admission she was greatly excited and flew into a violent rage upon the slightest provocation, becoming purple in the face and requiring large doses of hypnotics to keep her orderly. Later she became more quiet and delusions of an exalted nature developed; these alternated with periods of depression.

The pupils have remained normal and the knee-jerks have become markedly exaggerated. The speech has grown more and more slow and difficult and the tremor of the facial muscles marked. The facies were characteristic. During 1896 she gained in flesh.

In 1897 she began to have convulsions. These varied in intensity, at times slight, at others heavy. These would occur at varying periods, happening three or four times a month and then not for a month or more. As the convulsions continued her nutrition decreased. The dementia and the ataxia becoming profound; she died August, 1897.

The examination of the blood was hurried as the patient was practically moribund at the time when the study was begun.

No counts were possible, but a differential count of the leucocytes was secured. This showed diminished lymphocytes and absence of eosinophiles, increase of mononuclear cells and increase of polymorphous cells.

CASE XX.—M. C., housewife; aged forty-nine. Admitted September, 1894. The family and antecedent history is negative. The onset of the malady was gradual. She was irritable and forgetful and began to be slightly demented, later she had a few convulsions and following one had a partial hemiplegia and strabismus, which was however quite temporary (two weeks), the dementia making a distinct advance at that time. In November, 1894, and May, 1895, she had further convulsions and following one of these she had hemiplegia for six or seven days. Her speech gradually became of the characteristic type and her dementia progressed rapidly. Her delusions have always been of a depressed type rather than elated. Pupils were normal and the reflexes exaggerated. Nutrition remained excellent until just before death.

No blood examination was made in the case during life, as she died before the work was started, but a few smears were made post mortem and are here recorded as indications of the condition rather than of anything else, their value as data naturally being *nil*. It is interesting to note that the differential count of the leucocytes was normal, save for the entire absence of eosinophiles.

Tabulated the results are as follows:

Case.	Leucocytes.	Hæmocytes.	Sp. Gr.	Hæmog.	Lymphoc.	L. Monoc.	Trans.	Polym.	Eosin.
				Per Cent.					
I	4,200	6,800,000	1057	87	12	6	2.5	78	1.5
II	8,600	5,248,000	1059	90	5	10	2	81	2
III	6,950	4,900,000	1056	90	2.7	6.3	3.4	86.5	1.1
IV	6,700	5,040,000	1059	95	24	7	1	66	2
V	5,000	6,520,000	1057	85	8.5	6.5	.5	83	1.5
VI	15,000	6,000,000	1060	95	20	5.5	.5	71	3
VII	6,000	4,000,000	1052	78	15.3	7.7	.5	76	.5
VIII	7,200	5,816,000	1054	75	30	2	2	63	3
IX	4,500	5,456,000	1060	100	27	7	3	65	0
X	7,600	6,766,000	1058	88	20	5	2	71	2
XI	6,100	6,080,000	1047	52	23.5	8.5	4	60	4
XII	6,400	5,300,000	1060	90	15	9	2	74	0
XIII	10,000	6,490,000	1056	80	23	1	1	68	7
XIV	6,400	5,760,000	1060	95	21	16	2	60	1
XV	7,400	5,600,000	1057	80	8.5	10	.5	71	0
XVI	3,400	6,016,000	1047	65	14.5	11	1	71	2.5
XVII	3,500	6,096,000	...	...	4.5	8.5	0	87	0
XVIII	13,000	5,120,000	1050	65	25	5.5	1	66.5	2
XIX	...	blood,.....	...	...	9	9	2	80	0
XX	Post mortem			24	5	0	71	0	

## III.—SUMMARY OF OBSERVATIONS.

If the proper cases are excluded: Cases XIX, XX and perhaps IV; one having died, one having been moribund at the time of observation and one a suspect only, there still remain seventeen cases. In at least fourteen of them the number of red cells was increased, in eight over six million, in the remainder over five million. In two only the haemocytes were less than five million to the c.mm. With reference to the leucocytes, in four they were below five thousand, seven being below what has been taken as the general average, 7500, and in three only were ten thousand or over recorded. In nearly all the haemoglobin was reduced and, correlatively, the specific gravity.

Thus the results of Capps and all others with reference to the haemoglobin and specific gravity, as would be expected, is borne out, but the figures bearing upon the number of red cells and leucocytes are, for the major part, the direct reverse. Looking at the differential count of these seventeen cases it was found that in one the lymphocytes were increased, or, rather, were at the upper limit; in seven normal and in ten decreased. Of the large mononuclear leucocytes, seven cases showed an increase above the limits, as laid down by Cabot, two had a decrease and ten were normal. The poly-morphonuclear elements are averaged from 60 to 70 per cent by Cabot; the counts of the cases recorded show thirteen to be normal and six an increase.

The eosinophiles were increased above the normal in one case only, but it is of interest to record their absence in five cases at least of undoubted general paresis.

In attempting to correlate our results with those of previous observers we would extend the earlier interpretations.

The haemoglobin may sink below 70 per cent as has been noted in three cases, in one of which 52 per cent was recorded; Lewis records as low as 53 per cent. The specific gravity in our cases ranged from 1047 to 1060, showing a wider range at least downward (Capps 1058).

Capps records an average of twenty-two per cent of leucocytosis. We cannot help but feel that the influence of digestion leucocytosis had not been properly compensated for, although we know that he paid particular attention to that point. The best authorities on physiological leucocytosis allow a variation of thirty-three per cent and, as once noted, Cabot states that one may expect to find in normal human blood all the way from 3000 to 10,500 leucocytes.

The fact seems to remain, that we may expect to find as wide or a wider variation of leucocytes in general paresis than is found in normal blood, but nothing distinctive.

The lower range is indicative of lowered vital tone, and maybe inability to get the best from the food that is provided; and the higher range is found in the cases where a general exalted condition characterizes the type of the disease. The highest register in our cases (15,000) was from such a type.

With reference to the red cells we are unable to account for the slight average grade of polycythaemia unless it is on the ground of a relatively higher altitude. A great number of observers have recorded an increase in the red cells correlated with the increase in altitude. Köppes' lists show that at above 414 and 425 metres the average count runs from 5,754,000 to 5,748,000.

The Binghamton Hospital is about 400 metres above the sea and we may interpret our figures along some such line as indicated. Yet we believe that the limits are within those of health and that as far as the haemocytes are concerned there is no general rule as far as general paresis is concerned.

With the results of Capps upon the number of lymphocytes, the present observations are in general accord. We note an average reduction in these cases, no one case containing more than thirty per cent, which is recorded as the upper limit of this unit. In general also a relatively high percentage of large mononuclear leucocytes was found, only two being below the normal. Nothing of note was observed of the transitional cells.

In these cases the eosinophile cells showed a wide variation, thus agreeing with the statements of other authors. Their entire absence, however, has not been commented upon.

As a final word of conclusion we cannot but feel that in general paresis there are no marked constant blood changes beyond the reduction in the percentage of haemoglobin. Perhaps the only point that has been brought out in the résumé of all of the literature is the fact that we may expect to find deficient formation of lymphocytes as evidenced by the generally found diminution of these elements.

The sum of the observations thus far reported would also point to an increase in the large mononuclear leucocytes.

Further study may, however, reveal generalizations of a wider character.

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